

APPENDIX 2. PROTOCOL FOR MONITORING REPRODUCTIVE SUCCESS, GROUP SIZE, AND GROUP COMPOSITION (COLOR-BANDING)

Monitoring reproductive success and group size is accomplished by periodic visits to the nest, color-banding all nestlings and unbanded adults, conducting fledgling checks and/or late-nestling checks, and identifying all banded adults throughout the breeding season. This appendix provides information on: (1) nest checks, (2) aging nestlings according to Ligon age characteristics, (3) capturing and color-banding nestlings, (4) capturing and color-banding adults, (5) fledgling or late nestling checks, (6) color-band observation, (7) determining group composition, and (8) data management.

1. Nest Checks

Nest checks consist of repeated visits to the cluster on a 7 to 11 day cycle until a nest is found. More frequent nest checks subject the birds to unnecessary disturbance for little additional information. Less frequent nest checks greatly increase the likelihood that nestlings will be too old to band when found, and nest failures may go undetected.

Each active cavity tree in the cluster is a potential nest site, although nests are typically found in the most active cavity tree and often in the most recently completed cavity. Locate nests by observing adult behavior (e.g., flushing from a cavity during the day, tending nestlings) and/or inspecting contents of active cavities using Swedish ladders or a video probe. Once a nest is located, observe and record contents, including number of eggs or nestlings and nestling age (see below), as well as other relevant information such as date, time, and cavity, cavity tree, and cluster identification numbers. Schedule the following nest visit by optimal banding age (see below). If a discovered nest contains eggs, return to the cluster in 7 to 11 days. After nestlings are banded, it is not necessary to return to the site until the late/nestling check or fledgling check, whichever is used (see below).

If a nest fails before nestlings have fledged, return the cluster to the nest check cycle to detect renesting. If no nest is observed within a cluster, conduct a morning follow of group members (3A) and survey for new cavity trees within suitable habitat in and near the cluster (3A).

During nest checks, identify all adults present by color-band observation and record their color-band combination and activity (e.g., incubating, feeding nestlings, conflicting with other adults). This information is important to determining group composition (see below).

2. Aging Nestlings

Nestlings are aged according to descriptive characteristics set out by Ligon (1970; Table 20). Aging of nestlings is done with extreme care and attention to detail.

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TABLE 20. Nestling characteristics indicative of nestling age, in number of days.

Nestling Age	Character	Description
DAY 0	SKIN BILL WINGS RETRICES FEET SIZE	Loose and pink Mandible roughly 2mm longer than maxilla; diamond-shaped egg-tooth on maxilla Permanently extended and used to remain upright Bumps Heel pad greatly enlarged Appears small enough to fit back into egg
DAY 1	SIZE	Appears that the body would fit back into shell, but not the head
DAY 3	REMIGES	Dots visible
DAY 4	SKIN BILL TRACTS	Tail darkening Turning black except for egg tooth Back, wing, and scapular tracks visible
DAY 5	SKIN TRACTS	Skin darkening Crown, lower neck, and most of spinal, femoral, and ventral tracks visible
DAY 6	BILL EARS RETRICES	Maxilla almost as long as mandible Open Bristles visible
DAY 7	TRACTS FEET	Crural tracts visible Increasing in size
DAY 8	SKIN BILL RETRICES REMIGES FEET	Darker Maxilla and mandible are about equal in length Protruding Quills protruding from skin Darkening
DAY 9	EYE RETRICES FEET	Opening Exposed short distance Extended toes 34 mm
DAY 10	REMIGES TRACTS FEET	Quills showing Well developed; feather tips exposed at tail, rump, slightly on breast, and on lower abdominal tract. Quills of middle and lesser coverts, humeral tract, and spinal tract showing. Feet and tarsi dark, heel pads light, losing knobs and tubercles
DAY 11	BILL REMIGES TRACTS BEHAVIOR	Maxilla slightly longer than mandible, culmen 11 – 12 mm 1 st secondary 8mm, 2 nd primary 7 mm Feather tips of spinal, scapulars, anterior ventral and crural tracts showing Call changes to more adult-like
DAY 13	RETRICES REMIGES	Quills 6.5 – 7.5 mm Outer primary quills about 25 mm; longest primary 18 – 25 mm

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TABLE 20 (cont.). Nestling characteristics indicative of nestling age, in number of days.

Nestling Age	Character	Description
DAY 15	RETRICES	Quills 16 – 18 mm
	TRACTS	Feathers still largely sheathed
DAY 16	BILL	Culmen 14 mm
	REMIGES	Longest primary 27 mm (sheath 20 mm)
	TRACTS	Erupted feathers covering much of body surface
DAY 17	TRACTS	Feather sheaths on pileum of males broken away except for those of red crown patch
DAY 19	RETRICES	Longest feather 29 mm and quills beginning to break away
	REMIGES	Longest primary 45 mm and quills beginning to break away
	TRACTS	Body covered with feathers except for abdomen and flanks
	BEHAVIOR	Active and pecking at observer's hand

3. Capturing and Color-banding Nestlings

Nestlings are banded between the ages of 5 to 10 days old. Banding nestlings older than 10 days in age is prohibited because of greatly increased risk of injury and mortality. Banding nestlings younger than 5 days old is not possible because they cannot accommodate three color-bands on one leg. In southerly parts of the range, nestling 5 or 6 days in age may not be large enough to wear three color-bands. In these regions, narrow the window of banding opportunity to 7 to 10 days in age.

Nestlings are captured and carefully removed from the nest cavity using a soft noose liberally lubricated with cornstarch (Jackson 1982). Nestlings must be kept warm and dry, and out of direct sunlight, while out of the nest.

Each individual is banded with a unique combination of color-bands (size XB) and a U.S. Geological Survey aluminum band (size 1A). Nestlings and adults (see below) are banded with three color-bands on one leg and the aluminum band, with or without an additional color-band, on the other leg. Birds are not to be banded with one or two color-bands alone on a leg, because color-bands that move excessively can cause injury to toes. Birds are not to be banded with more than a single color-band on the leg carrying the aluminum band. Therefore, we recommend that both legs be banded. If only one leg is banded, color-band combinations are reduced to a single color-band and the aluminum band.

Once nestlings are banded, check the accuracy of the band combination several times. Record necessary data on banding sheets. Return nestlings to the cavity.

4. Capturing and Banding Adults

Adults are captured for banding or color-band replacement following the breeding season, or at any time other than the breeding season, unless the bird in question cannot be caught except during breeding (e.g., a female without a roost cavity). Aluminum bands are never replaced, and are only removed if the band is causing injury. Color-bands may sometimes need replacement, but capture of adults should be minimized to the fullest possible extent.

Adults are typically captured at the roost cavity at dawn or dusk with a net attached to a telescoping pole. Adults will not be caught at night, except those captured for translocation that evening and for specific research needs with appropriate permits. Adults will also not be caught during wet weather; handling wet birds can kill them. Adults are banded in the same way as nestlings: three color-bands on one leg, and the aluminum band with or without an additional color-band on the other leg.

5. Fledgling or Late Nestling Checks

Fledgling checks or late nestling checks are performed to determine how many nestlings survived to fledging, and the sex of those individuals. Fledgling checks are preferable to late nestling checks because the accuracy of survival estimates are improved and because fledgling checks are an important time to identify adult members of the group. However, late nestling checks may be substituted if time and personnel are constrained.

Conduct fledgling checks for each banded nest between 2 and 14 days after the projected fledging date (26 days after estimated hatching date). Fledgling checks last a minimum of one hour or until all nestlings banded are seen as fledglings. Record number of fledglings, their color band combinations, and their sex. Determine sex by unobstructed views of the fledgling's entire crown: females have a black crown and males have a red crown patch. If a banded nestling is not detected as a fledgling during the one-hour fledgling check, conduct a second check within ten days. If no fledglings are detected in these two checks, examine active cavity trees for an additional nest attempt.

Conduct late nestling checks before the 21st day after estimated hatching date. If nestlings are disturbed at age 21 days or older, they may fledge prematurely. During a late nestling check, identify, count, and sex all nestlings and record these data.

6. Color-band Observation

Using spotting scopes, identify and count adults whenever they are encountered. Most observations are made during nest and fledgling checks. Do not count birds by sound alone. Record color-band combinations, cluster, date, and behavioral data such as tending young or conflicting with other adults present. Verify unexpected color-band combinations.

7. Determining Group Composition

Group composition is determined using color-band observations described above. Breeding male status can be assigned to a male if any one of the following criteria are met: (1) he is the only male in the group, (2) he is the oldest male in the group, (3) he roosts in the nest cavity, or (4) he was the breeding male in the previous year. Once the breeding male has been determined, other adult males present are assigned helper status if they are on their natal territory or if they were seen incubating, tending young, or interacting peacefully with other adult members of the group. Breeding female status is assigned to a female if (1) she is the only female, (2) she is the oldest female in the group, or (3) she was the breeding female in that group in the previous year. Other adult females are assigned helper status only if they are on their natal territory.

Birds that are observed in conflict with group members are intruders from a nearby group or non-breeding adults without a group (floaters). Extra adult females that peacefully

interact with a group, but are not on their natal territory, sometimes occur. The role of these auxiliary females deserves further research.

In cases where group composition or individual status remains uncertain, conduct a morning follow (3A) or roost check. This will enable determination of which bird roosts in the nest cavity as well as locate breeders or helpers not seen previously. Old breeding males, for example, may be especially hard to observe during nest and fledgling checks. If it appears that an old breeding male is no longer present, a morning follow or roost check is recommended to verify his disappearance.

8. Data Management

We recommend that data be stored using database management software rather than spreadsheets or other software types. Of course, data management will vary according to research and species management needs.

However, for monitoring reproductive success and group size, it is useful to keep at least these two separate data sets: (1) the first containing one record for each individual in each breeding season, and including information such as color-band combination, age or minimum age, status (e.g. helper or breeder), cluster, and year; and (2) the second containing one record per group per year, including information such as the number of eggs, nestlings, and fledglings produced, whether or not a nest was attempted, and group size. Group size should not include fledglings. Managers may consider creating a third data set that contains one record for every time a bird was observed, although this is time-consuming. Other data sets can be created as needed.